DOCUMENT RESUME

ED 428 044 SP 038 326

AUTHOR Turner, Herbert M., III
TITLE Mathematics Teaching in the 1990's: Are Pacesetter Mathematics Teachers Teaching from the Standards?
PUB DATE 1998-04-17
NOTE 20p.; Paper presented at the Annual Meeting of the American Educational Research Association (San Diego, CA, April 13-17, 1998).
PUB TYPE Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE EDRS Price MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS Elementary Secondary Education; *Mathematics Instruction; *Mathematics Teachers; National Standards; Student Evaluation; Teaching Methods
IDENTIFIERS National Council of Teachers of Mathematics; NCTM Professional Teaching Standards

ABSTRACT

This study examined whether Pacesetter Mathematics (PSM) teachers were teaching from the National Council of Teachers of Mathematics (NCTM) standards as they implemented the standards-based PSM curricula. The standards identified four teacher instructional practices as essential: choosing worthwhile mathematical tasks, orchestrating classroom discourse, creating an environment supportive of mathematical power, and analyzing students' understanding and the contribution of his or her practice to students' learning. Prior to implementing the PSM course in 1992, teachers attended an 8-day summer institute that provided, among other things, guidelines on instructional practices that reflected the vision of the NCTM standards. In 1994-95, 10 PSM teachers responded to pre- and post-surveys, teacher interviews, and classroom observations. Data on PSM teachers' instructional practices were analyzed to determine whether their instructional practices were in accordance with the standards. Results indicated that instructional practices of PSM teachers fell short of the NCTM's standards. Time constraints and level of teacher commitment were among the reasons cited for the shortfall. (Contains 10 references.) (SM)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

Running Head: TEACHING FROM THE STANDARDS

ED 428 044

Mathematics Teaching in the 1990's:

Are Pacesetter Mathematics Teachers Teaching from the Standards?

Herbert M. Turner, III

University of Pennsylvania

SP038326

A paper presented at the meeting of the American Educational Research Association
San Diego, California
April 1998

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY

H. Turner

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☐ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

Abstract

This paper addressed the question: Are Pacesetter Mathematics (PSM) teachers teaching from the Standards as they implement the Standards-based Pacesetter Mathematics curricula? Prior to implementing the PSM course in 1992, teachers attended an eight-day Summer Institute that provided, among other things, guidelines on instructional practices that reflected the vision of the National Council of Teachers of Mathematics (NCTM) Standards. Data on PSM teachers' instructional practices collected from a 1994-95 evaluation of PSM by research staff at the Educational Testing Service were analyzed to determine whether PSM teachers' instructional practices were in accordance with the Standards. Results indicated that instructional practices of PSM teachers fell short of the NCTM's Standards. Time constraints and level of teacher commitment were some reasons cited for the shortfall.

Introduction

The National Council of Teachers of Mathematics' (NCTM's) "Curriculum and Evaluation Standards for School Mathematics (1989)" and "Professional Standards for Teaching Mathematics (1991)" are considered important milestones in the quest to improve k-12 mathematics education in the United States. Together these standards set forth new vision for curriculum, evaluation, and instruction for secondary school mathematics (Mumme & Weissglass, 1989). When a draft version of the Curriculum and Evaluation Standards were released in 1988, NCTM President, John Dossey, asked the NCTM's Research Advisory Committee (RAC) to review the document and identify the research activities it engendered. RAC recommended that research should focus on implementation of the Standards such as the challenges classroom teachers encountered as they interpreted and took steps towards teaching from the Standards (Silver, 1988). A study by Stephens and Romberg (1985) of the Reality in Mathematics Education (RIME) curriculum found that classroom teachers faced a number of challenges when they were asked to teach typical mathematics content in atypical ways. One RIME teacher remarked,

> In RIME, there is a fair chance that someone will put forth an idea, or give you an answer which you haven't anticipated. That puts the teacher on edge, when they first teach RIME.

Another RIME teacher commented, "[A difficulty is] setting the story and getting students in the right frame of mind to do the lesson; that is, getting the students to accept a different form of teaching."

Since the release of the draft version of the Curriculum and Evaluation Standards, a

review of the k-12 mathematics education literature found few published studies on the use of evaluation research to understand how classroom teachers implement Standards-based curricula reforms. To address this issue, the Educational Testing Service (ETS) staff within the Education Policy Research Division at ETS conducted a 1994-95 pilot summative evaluation of the Standards-based Pacesetter Mathematics (PSM) course developed by The College Board. The PSM course provides secondary school students in their fourth year of mathematics with an introduction to, and strong foundation in, the applications of mathematical functions to model real-world problems. It is comprised of six units covering topics ranging from linear functions (Unit One) to rates of change (Unit Six). The task sets within each unit are drawn from the lives of students and the world around them. For example, Unit Five develops the concept of modeling with Matrices using a Sound Store and Markov's Mini Mall.

In summer of 1992, The College Board offered an eight-day intensive Summer Institute to pilot the PSM curriculum. The curriculum was designed to fulfill the vision set forth by the Standards. At the Institute, teachers received information on PSM course objectives, and the Standards-based instructional approach envisioned by PSM course developers and program administrators. After the institute, the expectation was that during the school year PSM teachers' instructional practices would exhibit each aspect of the *Standard*s. Thus, it seems natural to ask: Are PSM teachers teaching from the Standards? This paper reviews the NCTM's Standards to characterize the instructional practices it engenders, and examines results from the 1994-95 pilot summative evaluation of PSM to determine whether PSM teachers' actual instructional practices exhibited these characteristics.

Teaching from the Standards: Characterizing Instructional Practices

In contrast to popular perceptions, the NCTM's Curriculum and Evaluation Standards describe a vision for school mathematics; they do not prescribe a curriculum (Crosswhite, 1989). The NCTM's vision is that secondary school mathematics curricula in the United States reflect their historical purpose of preparing students for daily life, effective citizenship, and non-mathematical occupations or post-secondary education requiring knowledge of advanced mathematics (NCTM, 1989, p.123). Anticipating that local options and local initiatives would determine how well, and to what extent the vision of the Standards would be realized, the NCTM developed the Curriculum and Evaluation Standards to permit a wide variation in the specific mechanisms (such as textbooks or teaching methods) of curricula that would realize its vision (Crosswhite, 1989). For example, within the Standards-based PSM course materials, content emphasis, and embedded assessments are specified, but a particular mathematics textbook or teaching method is not.

The Professional Standards for Teaching Mathematics (1991) identified four teacher instructional practices that support the vision in the Curriculum and Evaluation Standards (Lappan, 1993). These are:

1) Choosing worthwhile mathematical tasks
2) Orchestrating classroom discourse
3) Creating an environment supportive of mathematical power
4) Analyzing students' understanding and the contribution of his or her practice to students' learning

Choosing Worthwhile Tasks. The Professional Standards for Teaching Mathematics

defines choosing worthwhile mathematical tasks as choosing tasks that promote students developing more productive notions about mathematics by providing them with opportunities to do mathematics. In doing mathematics, students explore interesting mathematical situations, look for patterns, make conjectures, look for evidence to support conjectures, and make logical arguments for their conjectures. Teachers who choose worthwhile mathematical tasks offer opportunity for students to engage in sound, significant, and relevant mathematics as a part of accomplishing the task (Lappan, 1993).

PSM course developers designed the various course-unit task sets to include problem situations drawn from the lives of students and their world (The College Board, 1996). For example, the Mile Run task set in Unit One provides PSM students with a table of the record-setting times for the mile run between 1954 and 1993. In analyzing the record-setting mile run times, PSM students are provided with the opportunity to explore the concept of linear function with interesting real-world data. Teacher's frequent use of PSM tasks sets is evidence that students are being presented with worthwhile tasks. The Institute's faculty suggested also that teachers use the PSM materials as a spring-board to other traditional math text books as a means of integrating the new materials into their classrooms. To gauge whether PSM teachers were providing worthwhile tasks, results of the 1994-95 pilot summative evaluation were analyzed to determine:

- How often are PSM teachers using the PSM course-unit task sets?
- Are PSM teachers using the PSM course-unit task sets as a springboard into traditional math textbooks?

Classroom Discourse. Orchestrating classroom discourse is the way of representing, thinking, talking, agreeing, and disagreeing as teacher and student strive to make sense of mathematics (NCTM, 1991, p.36). Teachers play many roles in the classroom that have a great influence on what sense students make out of mathematics (Lappan, 1993). One of these roles is that of a role model. The teacher as a role model demonstrates to students the multiple paths, the false starts, the thinking, and the effort entailed in problem solving. In other words, the mathematics teacher as a role model does not give the impression that mathematical and quantitative ideas are the product of authority or wizardry (NCTM, 1987, p.64). To gain insight into this instructional practice, the data from the 1994-95 pilot summative evaluation were analyzed to address the following questions:

- Do PSM teachers who use the PSM task sets regularly act as role models in the classroom through modeling math problems in the classroom?
- Is there a relationship between years of experience teaching PSM and PSM teachers acting as role models in the classroom?

Classroom Environment. The classroom environment should provide students with mathematical power (Lappan, 1993). Mathematical power is the students' capacity for integrating, applying, and communicating their mathematical understandings. Environments supportive of mathematical power will encourage students to (1) explore mathematical concepts, (2) develop careful reasoning and disciplined understanding, and (3) communicate their mathematical ideas.

PSM course-unit task sets are designed to provide students with opportunities to explore mathematics in real-world settings (The College Board, 1996). The task sets

emphasize student habits of mind, which include careful reasoning and disciplined understanding. Using the task sets on a daily basis, PSM students practice exploring mathematical concepts, using careful reasoning, and developing disciplined understanding. Integrated in all PSM task sets is the process of communication (The College Board, 1996). In particular, the task sets are designed to provide students with the opportunity to communicate the results of their work orally or in writing. In other words, the expectation is that PSM teachers will provide their students with opportunities to communicate the mathematics they learned in the classroom. To gauge whether teachers met this expectation, data from the 1994-95 pilot summative evaluation were analyzed to answer the following question.

- How often are PSM students provided with opportunities to communicate their mathematical reasoning?

Analysis of Student Learning. Analysis of student learning refers to classroom teachers' regular assessment of student progress for the purpose of making instructional decisions that foster the mathematical development of all students (NCTM, 1989). Classroom teachers assessment of student performance should not rest only on skill level items, because it sends the wrong messages about what is important in the mathematics curriculum (Lappan, 1993). Within the PSM course-unit task sets, student learning is guided by questions posed concerning the problem presented within the particular task set. PSM Teachers use these questions (or embedded assessments) to assess student progress as their students work through the task sets. The following question will be answered from the data analysis to determine whether this instructional practice is common among PSM teachers:

- What are the alternative forms of assessment and how frequently are they used by PSM teachers?

Methods

Sampling

The College Board staff projected that by the start of the 1994-95 school year approximately 180 teachers from 46 school districts (44 public, 1 private, and 1 community college) in the United States intended to offer PSM. ETS research staff targeted 36 teachers from The College Board's alphabetical listing of teachers intending to offer PSM during the 1994-95 school year for intensive data collection. In addition to receiving PSM pre- and post-course surveys, these teachers were interviewed at their schools and observed in their classrooms. Teachers for this intensive data collection were chosen based on location -- mainly for reasons of convenience in observing classes and interviewing teachers – from the following states: Connecticut, Delaware, New Jersey, California, Florida, and North Carolina. Some effort was made to include teachers with one, two, and three years of experience with PSM, and to involve at least a few teachers with multiple PSM classes.

Ten of the 36 teachers identified for intensive data collection were dropped because they identified complex procedures associated with gaining School District permission to be a part of the evaluation. Data on instructional practices was eventually collected from 17 teachers. Of these 17 teachers, 12 teachers participated in at least two of the three research activities—survey, interview or classroom observations. (Data from one activity was used to corroborate data collected from another.) Data from these 12 teachers, hereafter referred to as the intensive sample, were analyzed and reported in

this study.

Results

Demographics

Ten teachers responded to the pre- and post –surveys and also participated in either the teacher interview or classroom observations. Two teachers participated in the interview and classroom observations, but not the survey. Eight teachers participated in all three activities (Appendix 1).

Survey data showed that 80% of teachers in the intensive sample were female. Fifty percent reported between 10 to 20 years teaching experience, 40% reported more than 20 years teaching experience, and 10% reported 6 to 9 years teaching experience. Seventy percent of teachers had earned advanced professional teaching certification.

Survey data also showed that teachers taught an average class size of 27 students, but class size varied from 17 to 36 students. Fifty percent of teachers characterized their students' level of math preparation as good, 40% characterized this level as fair, and 10% characterized the level as excellent. With regard to the PSM course selection criteria, 10% reported that they selected students based on the students' previous grades, while 10 % of the students were recommended by a previous math teacher. Most PSM teachers reported that students were either self-selected (40%) or entered the course by some other process (40%). With regard to the frequency of PSM class meetings, 50% of PSM teachers reported their class met five times a week, 30% reported three times a week, and 20% reported twice a week.

Worthwhile Tasks

Table 1 shows that on the teachers' survey, 40% of the responding teachers

reported using the PSM course-unit task sets on a daily basis. The results of the teacher interviews showed that only 36% used the task sets on a regular basis. The remaining PSM teachers reported using the course-unit task sets either once or twice a week (40%), or once or twice a month (20%). Although in interviews, 45% of the teacher reported using the course-unit task sets as a springboard to traditional mathematics textbooks, classroom observers documented only 33% of these teachers as using the PSM course unit task sets in this way.

Table 1

PSM Teachers Use of Task Sets

Use PSM Task Sets	(%)
(n=10)	
Once or Twice a Month	20
Once or Twice a Week	40
Almost Daily	40

Classroom Discourse

Classroom observers characterized 33% of PSM teachers in the intensive sample as blending the role of lecturer and facilitator. For example, at the start of the PSM lesson, the teacher lectured on the math-problem situation covered that day in the PSM course-unit task set. Two teachers were documented as demonstrating the math-problem situation using a computer simulated model, and encouraging class discussion. Upon completing the lecture, the teacher arranged PSM students into

groups to work on the math-problem situation. As the PSM students worked on the math-problem in their groups, the teacher would walk around the classroom posing questions to the student groups to facilitate their work on the math-problem situation.

Classroom observers characterized the instructional practices of the remaining two-thirds of PSM teachers as traditional. These teachers were documented as using the PSM course-unit task sets, but lectured most of the time to the PSM student, and did not promote extensive class discussion. More than half of the PSM teachers observed did not engage their students in group-work. In these cases, students remained seated in traditional seating arrangements (seats arranged in rows) while discussing the math-problem situation with a proximal classmate.

Table 2 shows that teachers in the intensive sample who taught PSM for more than two years were observed to be less traditional in their teaching than teachers in the same sample who taught PSM for less than two years.

Table 2

Role of PSM Teacher in the Classroom by Years of PSM Teaching Experience

Years of PSM Experience	Number of PSM Teachers	Role in the Classroom
1	1	Traditional
2	1	Traditional
3	2	Traditional → Facilitator
4	1	Facilitator

Note. Observer did not document Years of PSM Experienced for all PSM teachers observed.

Classroom Environment

Table 3 shows that at least once a month, the majority of PSM teachers in the

intensive sample provided PSM students with opportunities to write sentences about a problem or solution (90%), write reports or extended projects (80%), and communicate ideas effectively in writing (90%). More than half of the PSM teachers hardly ever provided students with opportunities to present their mathematical ideas to the class.

Classroom observers documented one teacher providing the opportunity to a student to present her work to the class. Although in the interviews, PSM teachers did not explicitly mentioned they provide opportunities for their students to communicate their mathematical ideas, 5 out of 11 did refer to being able to better observe their students' thought processes through using the PSM course-unit task sets.

Table 3

PSM Teachers Engaging PSM Students in Communicating Their Ideas

PSM Classroom Activity	Hardly Ever %	1 or 2 Times per Month %	1 or 2 Times per Week %
(n=10)			
Write Sentences About a Math Problem	10	60	30
Write Reports or Extended Project	20	80	0
Communicate Ideas Effectively in Writing	10	40	50
Present Ideas to the Class	60	30	10

Analysis of Student Learning

Table 4 shows that 60% of PSM teachers reported using multiple choice tests to assess student progress at least once a month. Fewer (33%) used written explanations, 30% used group projects, and 22 % portfolio collections at least once per month to

assess student learning. When interviewed, most PSM teachers reported using multiple choice tests or quizzes to assess student learning, although a few PSM teacher (n=2) mentioned the use or writing assignments to assess student progress. None of the PSM teachers interviewed reported regular use of the PSM end-of-unit assessments. Rather, PSM teachers reported selectively picking and choosing from some of these assessments, and relying on a combination of multiple choice tests with some PSM-like assessment questions dispersed among the multiple choice questions on the test. Table 4 summarizes these results.

Table 4

PSM Teachers Emphasis on Alternative Forms of Assessment

Assessment	Hardly Ever %	1 or 2 Times per Year %	1 or 2 Times per Month %	1 or 2 Times per Week %
Multiple Choice Tests	20	20	60	0
Written Explanation	0	67	11	22
Group Projects	40	30	10	20
Portfolio Collection	67	11	11	11

Note. n=10 except for Written Explanations and Portfolio Collections where n=9

Discussion

Are PSM teachers teaching from the Standards? It appears from this study that a majority of PSM teachers in the intensive sample are not implementing the PSM curriculum in accord with the Standards. Thus, the results suggest that the answer to the question is that a majority of PSM teachers in the intensive sample are not teaching from the Standards.

To teach from the Standards, PSM teachers in the intensive sample had to choose worthwhile tasks. Only 40% of the PSM teachers in the intensive sample used the PSM task sets on a daily basis. One common theme to emerge from the teacher interviews was that covering the material in the PSM course-unit task sets was more time consuming than covering similar topics in traditional math textbooks. Once PSM teacher remarked, "Teaching PSM requires us to cut out some of the concepts we usually cover in traditional textbooks." Time constraints may be one reason why two-thirds of PSM teachers did not use the task sets on a daily basis.

Only 33% of PSM teachers were observed using the task sets as a springboard into traditional math textbooks. Since this use of the task sets was emphasized during the eight-day intensive Summer Institute for PSM teachers, this result was surprising. In the teacher interviews, some PSM teachers spoke of the enormous amount of work in deciding which task sets to use and how to map the content in the task sets to the content in traditional math textbooks. A PSM teacher, in the teacher interview, mentioned working nights and weekends in preparation to teach PSM. Interestingly, one PSM teacher in the intensive sample who was also on the math faculty of the Summer Institute remarked, "Teaching PSM is more work than I ever imagined." The level of commitment needed to move to the top of the learning curve for teaching PSM is one of the challenges PSM mathematics teachers faced, and may be another explanation for the limited used of the PSM materials.

To teach from the Standards PSM teachers in the intensive sample had to orchestrate classroom discourse as role models. When observed, PSM teachers in the intensive sample were not role models, although some described themselves as such in

the questionnaires. Similar results were reported in the Third International Mathematics and Science Study (TIMSS) videotape study of middle school mathematics teachers. In the study, few teachers were found teaching from the Standards on the videotape, although many teachers reported teaching from the Standards on the TIMSS teacher survey. Teachers therefore need more opportunities for discourse on what actually constitutes Standard-based instructional practices.

The evidence in this evaluation study points to the possibility that as PSM teachers in the intensive sample gain experience teaching PSM, they expand their role beyond that of a traditional teacher. However, the evidence also suggests that PSM teachers expand their role to that of a facilitator, but not to that of a role model as described by the Standards.

To teach from the Standards, PSM teachers had to shape a classroom environment that supports effective communication of mathematical ideas. Although PSM teachers in this study did provide opportunities for student to express their mathematical reasoning through written explanations and group projects, this was not done as frequently as implied by the Standards.

To teach from the Standards, PSM teachers must regularly assess students' progress for the purpose of making instructional decisions that foster the mathematical development of their students. In the teacher survey, most PSM teachers reported infrequent use of multiple choice tests to assess PSM student learning. In contrast, during teacher interviews a majority of PSM teachers said that they often used multiple choice tests and quizzes to assess student learning, and sometimes use PSM end-of-unit embedded assessments or teacher developed Pacesetter-like assessments. One

PSM teacher remarked: "Part of the test will come from the book, and then we may use some problems from the assessment." Once reason for the infrequent use of PSM end-of-unit assessments may be the time pressure PSM teachers feel to move on to the next task sets or topic as is suggested by this teacher's comment, "Sometimes I don't get to the end of the task set, like ships in the fog, I stopped about in the middle of that [task set]: and it is one of those things where I make the call as I'm going along." Another reason may be the difficulty level of the assessment for a given level of students. One PSM teacher spoke to this point in remarking:

> Some of the assessments I don't really consider assessing what they [PSM students] know because the assessments are harder than what they have done. So I am not sure we assessed what they've learned because it goes too far beyond sometime.

Thus, the teacher interviews suggest for a number of reasons PSM teachers rely more on multiple choice tests and quizzes to assess student learning and as a result lack the broader view of assessment called for by the Standards.

Conclusion

For the sample of PSM teachers in this study, teachers' instructional practices fell short of the intentions of the developers of this Standards-based course. This finding is supported by contemporary evaluation research that also found few programs or curricula are implemented as intended (Rossi & Freeman, 1993). If this finding is valid for the larger universe of PSM teachers then examining the effect of PSM on student outcome may be pre-mature. Future research should use a larger randomly selected sample of PSM teachers to test the reliability and validity of this study's finding.

References

Coxford, A. F., & Hirsch, C. R. (1996). A common core math for all. Educational Leadership, 25, 22-25.

Crosswhite, J. (1989). NCTM standards for school mathematics: Visions for implementation. Arithmetic Teacher, 37, 55-60.

Rossi, P. H., & Freeman, H.E. (1993). Evaluation a systematic approach (5th ed.) Newbury Park: SAGE Publication, Inc.

Lambdin, D. V. (1993). The NCTM's 1989 evaluation standards: Recycled ideas whose time has come. Yearbook National Council of Teachers of Mathematics, 7-16

Lappan, G. & Friel, S.N. (1993). What do we have and where do we go from here. Arithmetic Teacher, 40, 524-526.

Mumme, J. & Weissglass, J. (1989). The role of the teacher in implementing the standards. Mathematics Teacher,82, 522-526.

National Council of Teachers of Mathematics (1989). Curriculum and evaluation standards for school mathematics. Reston, VA: The Council.

Silver, E.A. (1988). NCTM curriculum and evaluation standards for school mathematics: Responses from the research community. Journal for Research in Mathematics Education, 19,4, 338-344.

Stevens, M., & Romberg, I. A. (1986, April). Reconceptualizing the role of mathematics teaching. Paper presented at the annual meeting of the American Educational Research Association, Chicago, IL.

The College Board (1994). Precalculus through modeling. Teachers Edition, 1, 1-223.

Appendix I

Teacher Participation in 1995-96 Pilot Summative Evaluation Intensive Study

Teacher No.	Pre- and Post Survey	Teacher Interview	Classroom Observations	Full Participation
1	√	√	√	√
2	√	√	√	√
3	√			
4	√			
5	√			
6				
7				
8		√	√	
9	√	√	√	√
10	√	√	√	√
11			√	
12	√	√	√	√
13	√		√	
14	√	√	√	√
15	√	√		
16				
17	√	√	√	√
18	√	√	√	√
19		√	√	
20		√		
Total	13	12	12	8